INTERIM

SAFETY ELEMENT - DAVIS GENERAL PLAN

SEISMIC HAZARD SECTION

DAVIS COMMUNITY DEVELOPMENT DEPARTMENT

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SAFETY ELEMENT - DAVIS GENERAL PLAN

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I. INTRODUCTION

The safety and comfort of residents within a community is something which is increasingly being recognized as the responsibility of that community. Recent municipal legislation concerning everything from recycling programs to trains carrying bombs demonstrates the concern local governing boards have for the total environment of the city. On a state level this can be seen in laws which require municipalities to perform certain functions. The most general concerns overall safety. This is found in Section 65302.1 of the Government Code, as follows: "Safety element for protection of community from fires and geologic hazards. The general plan shall also include, in addition to the elements specified in Section 65302, a safety element for the protection of the community from fires and geologic hazards including features necessary for such protection as evacuation routes, peak load water supply requirements, minimum road widths, clearances around structures, and geologic hazard mapping in areas of known geologic hazards."

A related law comes under the list of required elements for general plans. This law, under Government Code Section 65302 (f) requires a Seismic Safety Element, as follows: "A seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiches. The seismic safety element shall include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards. That must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failures and seismically induced waves."

A. SEISMIC

1. Introduction

In view of California's location on the circum-Pacific belt of earthquake occurrence, earthquakes will continue to be a fact of life in the state as far into the future as can be imagined. Future seismic activity must therefore be prepared for in light of current information in the fields of engineering, building design, geology, soil science and seismology. As a result of some of the more severe earthquakes and in view of the continuing danger, the California Legislature has added to the statutes several laws directly related to seismic safety. The requirement for a seismic safety element in the general plan has already been discussed. In addition to fulfilling requirements of state law, this requirement serves to create awareness among civic leaders of the local seismic and geologic conditions. An awareness of these conditions and hazards will in turn encourage development of policies and plans of action to be used in the event of a quake. It is important that this awareness of hazards and procedures be made public so that the general citizenry is aware of the risk. This public awareness should also decrease the confusion following an earthquake and facilitate emergency procedures

Following the Long Beach quake of 1933 in which many school buildings were totally or partially destroyed, the Legislature passed the Field Act. Under this law the Department of General Services possesses the police power to supervise construction of new school buildings, as well as alteration to old school buildings if the loss exceeds $10,000, for the protection of life and property. At this point new school buildings are considered to be earthquake-resistant. The problem remains with older buildings which were never brought up to the Act's provisions. This is relevant for older cities primarily; Davis schools which are in use currently are all consistent with the Field Act. The Administration Building of the Davis Unified School District, formerly Emerson Junior High School, was the only local school condemned as a result of the Field Act.

The Riley Act, also passed as a result of the 1933 earthquake, concerns earthquake safety for virtually all buildings except those not intended for human habitation or those intended for two or less families outside an incorporated area. It requires buildings to be able to withstand a certain vertical and horizontal load without failing.

2. Seismic Setting

While these laws have been passed at the state level and therefore can not be undermined, what must be considered at the local level is community responsibility. What are the particular resources and experiences of the community? What particular hazards exist within the city and neighborhood? The particular geologic and structural conditions of the community must be looked at on a small scale to decide what local action is necessary.

In order to do this, the seismic setting of the area must be known. Relevant factors include proximity to active or potentially active earthquake faults, soils and geologic conditions, density and type of construction and location of dams and lakes. These factors will all be discussed further.

Davis is located in what has been classified by the California Division of Mines and Geology as Zone II, Moderate Severity Zone. (See Figure 1) This means that the greatest expectable earthquake to strike the area would have a probable maximum intensity of VII or VIII on the Modified Mercalli Scale and would probably result in no more than moderate damage. The Modified Mercalli scale is a subjective classification of earthquake severity based on probable levels of damage. The applicable zones are described in Figure 2. However, as of 1973 all of California has been classified as Zone III in the Uniform Building Code. For building purposes, therefore, the Davis area is included in the zone of greatest earthquake severity (See figure 3).

Past earthquake history in Davis is slight. (See Figure 4) The most significant quakes occurred on April 19 and 21, 1892. In Winters, 12 miles west of Davis, the first quake had an intensity between VIII and X. It destroyed most brick structures and damaged many frame buildings as well. The second quake, which was of equal intensity, levelled many buildings which had been left standing after the first quake. However,

in Davis the effects were limited to rattling windows and sloshing water in full water tanks. The only other significant quake was the 1906 San Francisco Quake. This one woke everyone in Davis and the surrounding area but no damage worth mentioning was reported.

This suggests that Davis is not very likely to suffer severe damage from a quake of equal magnitude to that of 1906 on any presently known fault.

Earthquake faults have great potential significance for urban planning. Active faults located adjacent to urbanized areas present a severe hazard in two different ways. The first is actual ground rupture. A building sitting astride an active fault will be subjected to a great deal of damage in an earthquake, depending on the severity of the quake. However, this is a less common hazard than ground shaking. With greater proximity to an active fault, ground shaking increases in intensity, and this is the factor which causes most damage in an earthquake. Davis is fortunate in not being located within an active fault zone (see figure 5). However, there are fault systems worth mentioning in relation to Davis seismic safety.

The San Andreas fault extends north along the coast all the way through California, turning out into the ocean at Mendocino County. This fault has been responsible for most of the destructive earthquakes in California. However, it does not extend to the Davis area and an earthquake with epicenter located on the San Andreas could not be expected to cause damage here. This has become apparent from past seismic activity, such as the San Francisco quake of 1906.

The Midland fault zone, located just west of Winters, has been documented by field studies of the California Division of Mines and Geology. Its last known activity was during the Eocene period of geologic time, approximately 50 million years ago. This is not considered an active fault system at this time.

The Division of Mines and Geology has discovered a series of faults along the western border of the Sacramento Valley. The most intense faulting has been found in Tehama County to the north of Yolo County. It is suspected that this is part of a major fault system in the coast ranges, which also is not considered relevant to Davis.

Overall, then, it can be stated that there is no active fault located close enough to Davis to cause severe seismic disturbance according to current information.

Within the seismic setting, types of hazards are significant. An earthquake occurs when movement is generated along a fault, resulting in shock waves which travel over an area known as the fault zone. In this context there are primary natural hazards, which are ground shaking and ground rupture along the surface trace of the fault. Secondary natural hazards result from a combination of these primary hazards with

the existing ground conditions, and include liquefaction, subsidence, landslides, seiches and tsunamis.

In addition, these natural hazards may interact with man-made structures, which can result in structural hazard. When a structure is not able to withstand the natural forces it will fail, and the potential for this is the structural hazard. In addition to the failure of buildings is the possibility of movement of objects within, on or adjacent to the structure itself.

3. Geology and Soils

Next to proximity to earthquake faults, geology and soils are probably the most important factors to consider when dealing with seismic safety. (See Figures 6 and 7) A perfect example of this was the 1906 quake in San Francisco in which the structures built on bedrock came through the earthquake itself with very little damage, while those built on fill land were almost totally destroyed.

Davis is located in the eastern portion of the Putah Creek Plain, which is one of the major geomorphic features of the southwestern Sacramento Valley. This valley is a down-warped trough underlain at depths greater than 17,000 feet by metamorphic and igneous rock over 120 million years old. Overlying these ancient rocks are layers up to 15,000 feet thick of marine and continental sedimentary rocks. These rocks are essentially non-water-bearing. The surface layers of the valley area are composed of up to 3,000 feet of water-bearing alluvial sediments. Most of these sediments are semi-consolidated. Only the uppermost layer, up to 200 feet in depth, is composed of unconsolidated alluvial deposits. These alluvial deposits have been separated into two broad groups, the older and the younger alluvium, based on the time of deposition. The older, basal phase, which varies from 15-60 feet in thickness, is composed of unconsolidated coarse sand and gravel deposits with discontinuous bodies of sandy silt, silt and clay scattered through out.

The younger alluvium merges with and is overlain by the fine-grained flood basin and stream channel deposits of the Sacramento River in the Yolo Bypass area, and forms the surface layer of most of the valley area It consists of sandy silt with occasional deposits of sandy clay and sand.

The soils within the planning area of Davis are primarily in the Sycamore, Reiff and Yolo series. The Sycamore soils are found on much of the central University land, south of I-80, and in East Davis. The overall picture of Sycamore soils is of somewhat poorly drained silty clay loams on alluvial fans. This soils are used for irrigated row crops, forage crops, truck crops, orchards, pasture, wildlife habitat and recreation. Within the series is a further breakdown into specific soil type. Most of the central University area extending somewhat north and extending east along the Southern Pacific tracks is Sycamore silt loam, drained. This is a moderately permeable soil with water holding capacity 10.0" to 12.0" and effective rooting depth greater

that 60". The primary use is irrigated sugar beets, tomatoes, alfalfa and other crops, plus wildlife habitat and recreation. To the north of town is Sycamore silty clay loam, drained also on alluvial fans. Permeability is moderately slow, surface run-off is very slow, erosion hazard is none to slight. Natural fertility is high, with an effective rooting depth of greater than 60".

The Reiff series is also present in large areas of the city of Davis. On the whole this series consists of well-drained very fine sandy loams on alluvial fans. These soils are used for irrigated row crops, forage crops, dryfarmed grain, wildlife habitat and recreation. Parts of the University on the west of the central campus and in the northeast part of town are Teiff very fine sandy loam. The permeability of this soil is moderately rapid. Surface runoff is very slow and erosion hazard is none to slight. The available water holding capacity is 8.5" to 10.0", effective rooting depth is greater than 60" and natural fertility is high.

The Yolo Series is also present significantly in Davis. This series is well-drained silt loams and silty clay loams on alluvial fans. East of 113 around the University Airport can be found Yolo silt loam. This soil has moderately slow permeability and water holding capacity 10.0" to 12.0".

To the northwest of town can be found Capay silty clay. The Capay Series is distinguished by moderately well-drained silty clays. The Capay silty clay has slow permeability with very slow surface runoff and little or no erosion hazard. Available water holding capacity is 6.5" to 8.0", effective rooting depth is greater than 60" and natural fertility is high.

In this northwest part of town no one soil type predominates. Along with Yolo Series soils can be found various other types, including the following: Zamora loam, consisting of generally well-drained loams on alluvial fans, moderately slow permeability, very slow surface run-off, erosion hazard none to slight. Natural fertility is high, rooting depth greater than 60". Brentwood silty clay loam, with moderately slow permeability, very slow runoff, erosion hazard none to slight. Effective rooting depth greater than 60", natural fertility high.

To the northeast of town interspersed with the Sycamore and Teiff series is Tyndall very fine sandy loam, drained. The Tyndall series is on the whole poorly drained, but this one has been improved by reclamation structures. Effective rooting depth is greater than 60".

North of Covell is another type within the Yolo series - Yolo silty clay loam. The permeability of this soil is moderately slow and water holding capacity is 10.0" to 12.0".

From an agricultural viewpoint, Davis' soils on the whole are excellent. most of the city is on Class I soils, defined by the Soil Conservation Service as very good land suitable for cultivation with no limitations. The land surrounding the city is all Class I or II, devined as good land suitable for cultivation with minor limitations. As can be seen

from the preseding discussion, the land in most areas is silty or sandy loams with good drainage, deep rooting capability and ample water holding capacity. There are also areas of Davis with high clay content. Clay holds more water than silts, sands, or loams and is therefore not as good since drainage is an important factor in agricultural production.

a. As far as subsidence and expansion are concerned, Davis soils do have some problems. There is a certain type of clay soil which tends to extremes of shrink and swell with dry and wet weather conditions. This is present to some extent in Davis, particularly west of Highway 113 in the Stonegate area. Here cracking in the foundations of some homes can be observed as a result of this shrinking and swelling. While this can be a problem for homeowners, it is not considered serious enough to warrant seismic concern.

b. With regard to buildings, Davis is such a low density city that there is little significant problem. There is no concern over sky-scrapers collapsing and falling into the streets, or of people being trapped in tall apartment buildings.

Residential: Davis is undergoing a great expansion at the present time, demonstrated by the fact that the population has almost doubled in six years. The impact of this is that many of the residential structures are new, and buildings constructed within the last 10 years have been found safe on inspection by structural engineers. Older residences may suffer some damage, but the chances of anyone inside being seriously injured due to structural failure during an earthquake is very minor. For residential structures the phenomenon of acceleration is significant. This factor is related to ground shaking and is particularly important for low-rise construction of no more than five stories.

Commercial: The business section of Davis is also experiencing growth at the present time. This is particularly true along G Street between Second and Third Streets where many older buildings are being replaced or renovated. New commercial buildings are being built in accordance with requirements for Seismic Zone 3, mandated by the 1973 addition of the Uniform Building Code. Under this new Code, buildings in Zones II and III may not be constructed of unreinforced masonry. Older structures which do not conform to these requirements will be dealt with in the discussion of policy.

c. Critical Facilities: Critical facilities are important to consider in seismic safety because they either, (1) Hold large numbers of people, or (2) are fundamentally important to the continued functioning of the City. Examples of the first category include theatres, large restaurants, public meeting halls. Also within this category but not under municipal jurisdiction are buildings of the University of California, such as large lecture halls, theatres, and the gymnasium. The second category of critical facilities includes electricity, gas and water service

facilities, communications centers, and transportation centers such as the train depot.

Because of the importance of these critical facilities, they must be examined more stringently than either residential or commercial structures. This will be discussed further in the discussion of policy. Specified critical facilities within Davis are shown on the Critical Facilities Map. The Fire Department is currently conducting an extensive inventory of critical facilities which will be included in the Safety Element upon completion.

4. Dams

Monticello Dam, located 23 miles west of Davis on Putah Creek, is the only dam located near enough to cause a potential crisis if struck by a quake. At the present time the Bureau of Reclamation is preparing a study of the dam which will be useful for seismic risk analysis. This report will not be ready for at least a year.

5. Seiches

The Yolo Bypass is significant in regard to seiche activity in Davis. The levees in this area are the responsibility of the United States Army Corps of Engineers rather than the County. Therefore Davis has little control over what happens to them, but their presence is very relevant. The levees have been built with a five foot freeboard to protect against subsidence, and maintenance crews continually check for weak points. They were built to hold any historically recorded volume of water -- in recorded history there has never been enough water present in the area for an overflow to occur. Under earthquake conditions, however, if ground shaking is severe enough, a closed body of water can begin to oscillate until it goes beyond the limits of its container. This is called a seiche. While this possibility must be kept in mind, there is little likelihood of a quake in the area strong enough to cause a seiche in the Bypass. The Corps of Engineers has no plans to study the possibility of levee failure.

6. Landslides

Due to the flat topography of the Davis area, landslides do not present a significant hazard.

III. GOALS, OBJECTIVES AND POLICIES

The overall goal of the Seismic Safety Element is to ensure that the community is as safe as possible from seismic activity, taking into account geologic, engineering, economic, aesthetic and social considerations. The seismic safety element is the first step in this process. However, geologic and other forms of technical background are only one aspect of it. The city itself must decide what its policy will be in dealing with earthquake probabilities. By gathering in one place information about local earthquake expectations and policy for dealing with seismic activity, the awareness of those involved is increased and their duties made easier in the event of a crisis.

The first factor here is risk analysis. What is the level of risk in a seismic event and what does the city want to do about it? There are three types of risk involved: risk to human life, to property, and of social disruption. Within these three categories there are levels of risk:

> Acceptable Risk: The level of risk below which no specific action by government is deemed necessary.
>
> Unacceptable Risk: The level of risk above which specific action by government is deemed necessary.
>
> Avoidable Risk: Risk not necessary to take because individual or public goals can be achieved at the same or less total cost by other means without taking the risk.

Because of Davis' relative lack of past seismic events, it is difficult for people to be conscious of the risk associated with earthquakes. While Davis is not located in a high risk zone,(See figures 1, 4, 5, 8), the city has not experienced seismic activity recently enough to know what the impact would be, considering current population and structural factors. Seismic and geologic knowledge is not currently sophisticated to the extent that we can say with certainty whether or not a serious quake will strike in any area. Because of Davis' low rise profile we need build only under conditions of acceptable risk. Risk management therefore entails emphasis of the existing pattern of low rise construction in geologically safe areas, etc. This serves seismic and aesthetic considerations at the same time.

In dealing with critical facilities, however, the approach must be more conservative. In discussing protective services such as fire, police, hospitals, communications and utilities, as well as buildings where large numbers of people gather or live, we must go beyond emphasizing the existing city pattern and develop policies which reflect the critical nature of these facilities.

Within this framework, specific objectives and policies are as follows:

Objective 1: Provide for structural safety in the event of an earthquake.

Action Programs:

1. Notify building owners of hazardous structural conditions
2. Establish deadlines for renovation or demolition of hazardous buildings.
3. Define areas of greater geologic hazard and adopt more stringent building requirements for these areas.
4. Periodically update seismically-relevant sections of the building code in light of local conditions.
5. Under proposed change in the Uniform Building Code,

provide for review of buildings designated as historical landmarks for possible application of less stringent building requirements.

6. Investigate phenomenon of acceleration for low-rise buildings.

7. Encourage Bureau of Reclamation to conclude study of Monticello Dam and establish emergency procedures

Objective 2: Provide for safety of critical facilities.

Policy: 1. Require soils studies prior to construction of critical facilities.

Action Programs:

1. Establish stringent structural criteria for hospital communication centers, public facilities, theatres, and other structures holding large number of people.

2. Establish and post emergency procedures for critical facilities.

3. Coordinate a structural hazards inspection program for critical facilities and establish criteria for mitigation of hazards.

4. Provide for coordination, repair and restoration of essential services and systems as required in an emergency.

5. Recognize and be aware of regulations concerning public school structures and UC buildings.

6. Recommend that accelerographs be installed in UC buildings.

Objective 3: Provide for continuity of government following an earthquake.

Action Programs:

1. Development an Earthquake Disaster Plan, coordinated with the City of Davis Emergency Plan.

2. Establish and maintain earthquake-resistant emergency operating centers.

3. Train Disaster Service workers how to react following an earthquake.

4. Encourage programs for training volunteers to assist emergency personnel following seismic activity.

5. Provide for coordination of emergency operations with other jurisdictions when necessary.

6. Encourage special districts to establish earthquake emergency procedures.

Objective 4: Provide for citizen awareness of and preparation for seismic activity.

Policies:

1. Maintain and publicize information for dealing with earthquakes.
2. Maintain and publicize evacuation routes.
3. Publicize new developments in seismic research.

Objective 5: Ensure continuity of public and private utilities following seismic activity.

Policies:

1. Require periodic maintenance and study to ascertain that water transfer facilities can withstand earthquakes of expected intensity.
2. Maintain emergency plans for water transfer facilities.
3. Encourage periodic examination and maintenance of gas and electricity transfer lines and development of emergency plan.
4. Promote periodic examination and maintenance of communication systems (telephone and telegraph) and development of emergency plans.

Action Programs:

1. Foster maintenance of railroad lines and development of emergency plan for continuity of operations.
2. Promote upkeep of state, county, city and private roads and development of emergency plans for continuity of operations.

Objective 6: Emphasize seismic safety through use of zoning ordinances and subdivision regulations.

Policies:

1. Require soil studies including subsidence, compaction and liquefaction prior to approval of subdivision maps.
2. Adopt floodplain zoning in areas subject to flooding by seismic disturbance.
3. Evaluate new development in terms of seismic risk.

Action Programs:

1. Prohibit extension of utility lines into geologic hazard areas.

Objective 7: Use the EIR process to ensure seismic safety of new projects.

Policies:

1. Require soils studies in EIR's of all development projects of significant size.

2. Require professional review of EIR's of projects in geologically questionable areas.

Figure 1:

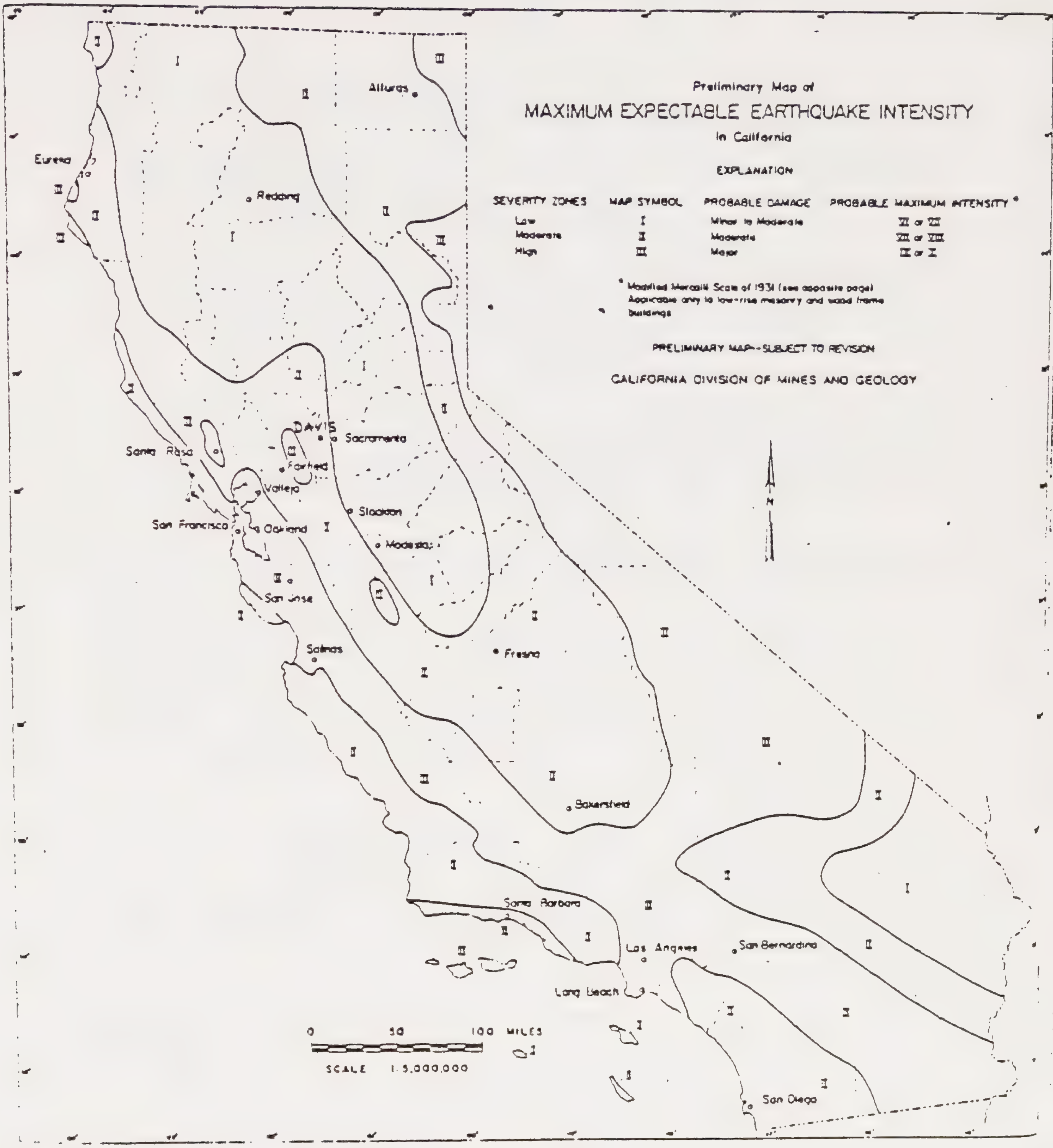


Figure 3. Preliminary map of maximum expectable earthquake intensity in California.

Figure 2:

Modified Mercalli Intensity Scale of 1931

(abridged)

I. Not felt except by a very few under specially favorable circumstances. (I Rossi-Forel scale)

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I and II Rossi-Forel scale)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel scale)

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel scale)

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel scale)

VI. Felt by all, many frightened and ran outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel scale)

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars. (VIII Rossi-Forel scale)

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII+ to IX Rossi-Forel scale)

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel scale)

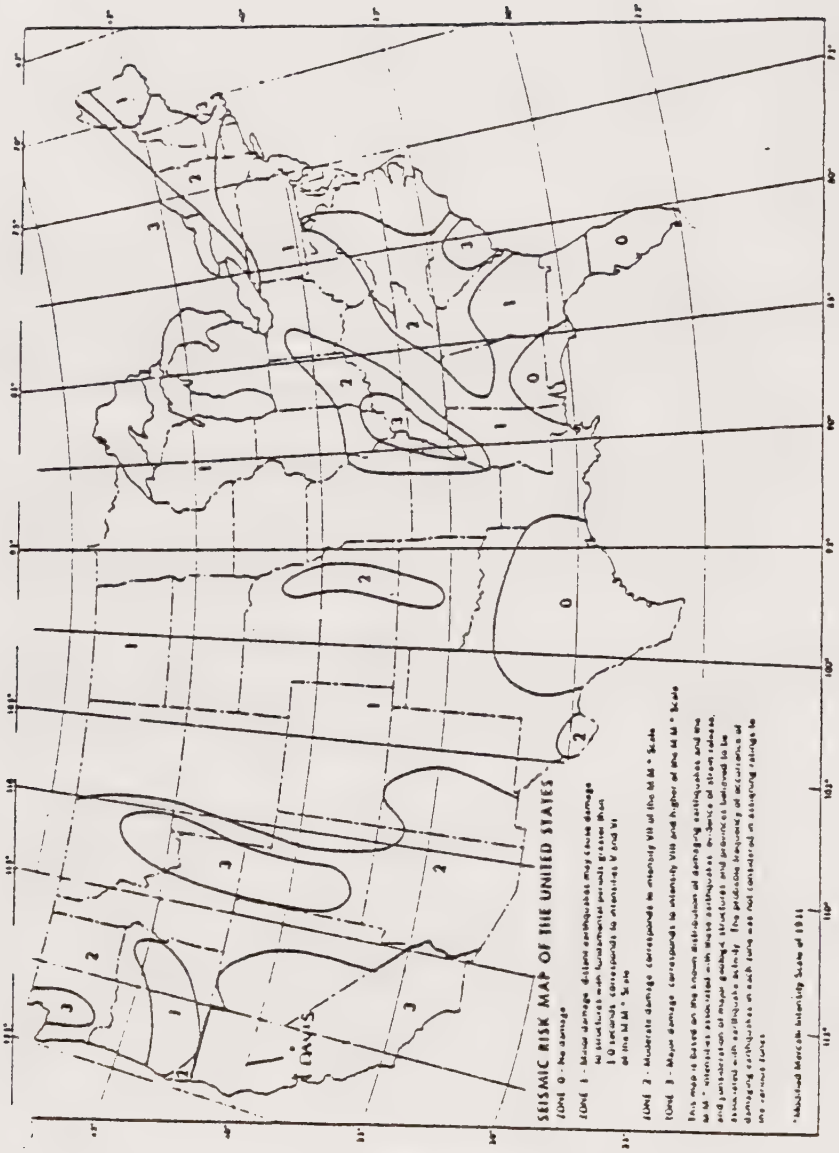
X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel scale)

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects throuwn upward into air.

"Modified Mercalli Intensity Scale of 1931", by Harry O. Wood and Frank Newmann, Bulletin of the Seismological Society of America, Vol. 12, No. 4, December 1931.

Figure 3:



- SEISMIC ZONE MAP OF THE UNITED STATES

Figure 4:

DATE	LAT	LONG	MAXIMUM INTENSITY, COMMENTS FELT IN
8/ 4/1850	38.25	121.33	Stockton and Sacramento (V)
3/15/1860	38.48	121.50	Sacramento, Epicenter probably in Nevada (VII)
5/21/1864	38.58	121.50	Sacramento (VI)
5/24/1866	38.58	121.50	Sacramento
5/25/1868	38.58	121.50	Sacramento
9/15/1869	38.58	121.50	Sacramento
12/20/1869	38.58	121.50	Sacramento and Reno
12/30/1869	38.58	121.50	Sacramento and Reno
7/10/1877	38.58	121.50	Sacramento, Carson City, Nevada
10/22/1878	38.58	121.50	Sacramento
1/31/1858	38.58	121.50	Sacramento (III)
4/ 2/1885	38.58	121.50	Sacramento (III)
4/ 3/1885	38.58	121.50	Sacramento (III)
4/19/1892	38.33	122.00	Solano County. Greatest damage occurred in Vacaville, Dixon, and Winters. Damage sustained also at Fairfield, Esparto, Capay, Woodland, Suisun, Benicia, Elmira, and Davis. Fissures on Putah Creek ½ mile west of Winters and near Vacaville. Sacramento and San Francisco felt this but sustained little damage. Felt as far north as healdsburg, but not in Ukiah. Felt as far south as Fresno and to the east as far as Western Nevada. (X)
4/20/1892	38.58	121.50	Sacramento and Nevada City
4/20/1892	38.33	122.00	Vacaville, Dixon, Winters, Suisun, Woodland, Stockton, Elmira, Martinez, Napa, Grass Valley.
4/20/1892	38.42	121.83	Dixon and Winters
4/20/1892	38.42	121.83	Dixon, Suisun, and Winters
4/21/1892	38.50	122.00	Winters
4/21/1892	38.50	122.00	Winters was most severely shaken (IX) Vacaville, Dixon, Woodland and Sacramento also were damaged. Other places where damage occurred were Fairfield, Esparto, Suisun, Martinez, Napa, Petaluma, Santa Rosa, Davis, Marysville, Biggs, Grass Valley, and Lodi
4/22/1892	38.33	122.00	Vacaville
4/22/1892	38.25	122.00	Suisun, Benecia, Napa, Dixon, Stockton, San Rafael Madison, Mt. Hamilton, San Jose, No comments from Winters, Esparto, Lodi, Sonoma, Oakland, or Lathrop.
4/22/1892	38.33	122.00	Vacaville
4/22/1892	38.67	122.00	Esparto and Madison
1/25/1893	38.50	122.00	Winters
1/25/1893	38.50	122.00	Winters
2/22/1893	38.25	122.00	Fairfield, Suisun, and Dixon
3/31/1893	38.33	122.00	Vacaville
4/17/1895	38.33	122.00	Vacaville
12/8/ 1895	38.25	122.00	Fullerton
2/20/1902	38.33	122.00	Vacaville

DATE.	LAT	LONG	MAXIMUM INTENSITY, COMMENTS FELT IN
5/19/1902	38.33	121.92	Elmira and Vacaville, Fairfield and Suisun (VII) Sacramento and Santa Rosa (VI) San Francisco Ione, and Stockton (V) Iowa Hills, Colusa, and Oakland (IV) Felt over an area of more than 20,000 square miles.
5/21/1902	38.58	121.50	Sacramento
5/25/1902	38.50	122.00	Winters
7/30/1904	38.67	121.75	Woodland, Stockton Berkeley, Napa, Rio Vista Sacramento, San Francisco, And Santa Rosa (VI)
5/20/1905	38.58	121.50	Sacramento
4/18/1906	38.58	121.50	Sacramento
4/19/1906	38.58	121.50	Sacramento (III)
8/12/1906	38.17	121.67	Rio Vista
5/31/1908	38.58	121.50	Represa
10/23/1916	38.17	121.67	Rio Vista and Martinez
10/23/1916	38.17	121.67	Rio Vista, Martinez, Lodi, Stockton, Oakland & Stanford University
6/28/1931	38.58	122.33	Richmond, Berkeley, Southampton Shaoal, San Francisco
7/18/1931	38.58	121.50	Sacramento
1/12/1934	38.10	121.40	Rio Vista (IV)
7/15/1939	38.20	121.50	Sacramento, Bssa, October 1939
9/ 2/1941	38.57	122.45	Moderate Size, (V) at St. Helena
4/15/1943	38.35	122.00	Vacaville
4/26/1943	38.15	121.60	Isleton
7/14/1944	38.50	122.30	NE of Santa Rosa
8/8/1944	38.55	122.03	West of Winters
8/13/1945	38.50	122.13	West of Winters
8/29/1945	38.48	121.93	East of Winters
9/ 7/1945	38.57	122.12	NW of Winters
9/16/1945	38.48	122.00	Near Winters
9/21/1945	38.47	121.87	This earthquake and those on 8/13, 8/29, 9/7 & 9/16 may have had a common focus
10/ 1/1945	38.25	122.00	Fairfield
10/11/1945	38.48	121.92	Near Winters
11/ 8/1945	38.53	122.10	Large Sinusoidal surface waves on all records
11/18/1949	38.30	122.00	Near Vacaville
11/30/1049	38.62	122.13	NW of Winters, (IV) in Fairfield, also felt in Sacramento
3/17/1950	38.37	122.23	North of Napa
12/ 1/1950	38.52	122.18	West of Winters
2/21/1951	39.00	122.50	East of Clear Lake, Felt in Talmage and Ukiah area
3/ 3/1951	38.78	122.17	NW of Esparto
11/ 9/1951	38.37	122.20	Near Napa
1/31/1952	38.45	122.33	North of Napa
2/ 7/1952	38.83	122.38	Between Middletown and Rumsey

1/ 7/1953	38.45	122.10	32 Miles east of Sant Rosa
3/ 9/1953	38.35	122.12	32 Miles east of Santa Rosa
8/28/1953	38.70	122.07	16 Miles SE of Berkeley
11/25/1953	38.30	122.10	30 Miles north of Berkeley
10/ 7/1954	38.15	121.80	30 Miles northeast of Berkeley
2/24/1955	38.40	122.12	49 Miles north of Berkeley
2/25/1955	38.40	122.12	East of Santa Rosa
6/27/1955	38.75	122.15	East of San Leandro. Felt Danville, Oakland
7/28/1955	38.75	122.15	Oakland Airport and San Leandro
12/15/1955	38.17	121.88	22 miles northeast of Berkeley
4/ 2/1956	39.00	122.50	ESE of Ukiah
6/ 5/1956	38.18	121.85	Northeast of Berkeley
11/ 3/1956	38.40	122.00	Southwest of Sacramento
2/16/1957	38.58	122.20	ENE of Santa Rosa
3/28/1957	38.40	122.20	East of Santa Rosa
5/22/1957	38.60	122.20	Northeast of Santa Rosa
6/25/1957	38.60	122.20	West of Sacramento
7/ 3/1957	38.27	122.03	NE of Berkeley. Felt at Fairfield
7/ 3/1957	38.27	122.03	NE of Berkeley. Felt at Cordelia
9/ 6/1957	38.38	122.22	East of Santa Rosa
9/18/1957	38.57	122.32	Northeast of Santa Rosa
2/ 1/1958	38.80	122.30	Northeast of Santa Rosa IV at Calistoga, Hobergs and Lower Lake
2/16/1958	38.53	122.32	East of Santa Rosa
2/16/1958	38.50	122.30	Aftershock of quake at 0756
2/16/1958	38.50	122.20	Aftershock of quake at 0756
3/ 5/1958	38.60	122.20	Foreshock of quake at 1710
3/ 5/1958	38.60	122.20	Northeast of Santa Rosa
4/20/1958	38.62	122.35	25 miles northeast of Santa Rosa. Felt at Monticello Dam, West of Winters.
4/20/1958	38.62	122.27	Aftershock of quake at 2106. Felt at Monticello Da
6/20/1958	38.60	122.10	West of Sacramento
7/ 2/1958	38.40	122.30	East of Santa Rosa
7/31/1958	38.38	122.15	East of Santa Rosa
8/20/1958	38.55	122.12	West of Sacramento
8/29/1958	38.50	122.00	West of Sacramento
10/31/1958	38.40	122.20	East of Santa Rosa
3/ 9/1959	38.62	122.08	West of Sacramento
11/19/1959	38.40	122.20	East of Santa Rosa
12/16/1959	38.58	122.37	Northeast of Santa Rosa Felt IV in Guerneville area Also felt at St. Helena, Napa, and Calistoga
3/31/1960	38.45	122.28	East of Santa Rosa
9/15/1960	38.37	122.08	West of Sacramento. Felt in Allendale-Winters area
1/10/1961	38.90	121.80	Northwest of Sacramento
3/ 8/1961	38.50	122.20	Southeast of Calistoga
5/ 6/1961	38.22	121.97	Southeast of Fairfield
7/ 1/1961	38.45	122.28	North of Napa
8/ 2/1961	38.17	121.67	Northeast of Concord
12/16/1961	38.17	121.75	East of Fairfield
6/24/1962	38.47	122.17	Northwest of Fairfield

CONTINUED 3

11/ 5/1962	38.82	122.43	Northeast of Calistoga
11/25/1962	38.42	122.28	North of Napa
12/29/1964	38.80	122.30	S of Rumsey
9/27/1967	38.73	122.19	W of Woodland
5/17/1968	38.45	122.18	NE of Napa
5/ 8/1969	38.70	122.17	East of Berryessa Valley. Felt in Yolo County Max. intensity IV in Brooks, Capay and Guinda
9/12/1969	38.60	122.30	30 KM WNW of Woodland
1/14/1970	38.70	122.25	50 KM south of Williams
5/24/1970	38.46	122.16	20 KM northwest of Napa
5/24/1970	38.46	122.16	Aftershock of 2309
8/ 3/1970	38.90	122.50	Near Cleak Lake, Felt at Lakeport.

Figure 5:

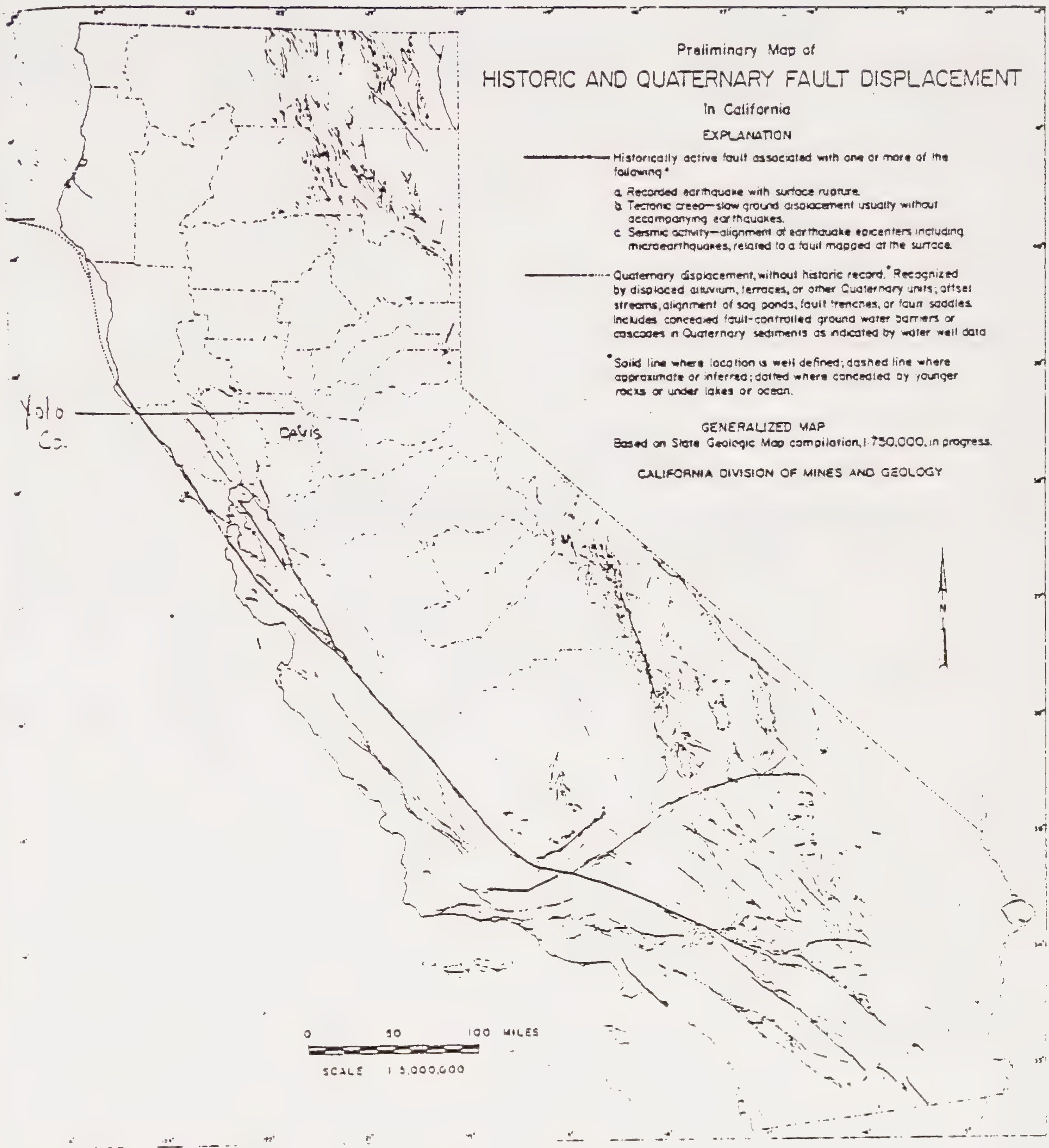


Figure 9. Preliminary map of historic and Quaternary fault displacement in California.

TABLE OF GEOLOGIC FORMATIONS BY AGE

Figure 6:

Era	Period	Epoch	Approximate Age in Years	Geologic Formation	Maximum Thickness in Feet
CENOZOIC	Quaternary	Recent		Stream Channel Deposits	?
				Flood Basin Deposits	?
				Younger Alluvium	40
			10,000		
		Pleistocene		Older Alluvium	150
			1,000,000	Tehama Formation & Related Continental Sediments	2,500
	Tertiary	Pliocene			
			12,000,000		
		Miocene		Basalt and Other Volcanic Rocks	?
			28,000,000		
		Oligocene			
			40,000,000		
		Eocene		Eocene Marine Sediments	7,000
			60,000,000		
		Paleocene			
			70,000,000		
MESOZOIC	Cretaceous			Consolidated Cretaceous Sandstones, Shales, and Conglomerates	15,000
			120,000,000		
	Jurassic			Consolidated Franciscan and Knoxville Formations Material	25,000
	Triassic		± 130,000,000		

Figure 7:

HYPOTHETICAL CROSS-SECTION OF PUTAH PLAIN AREA

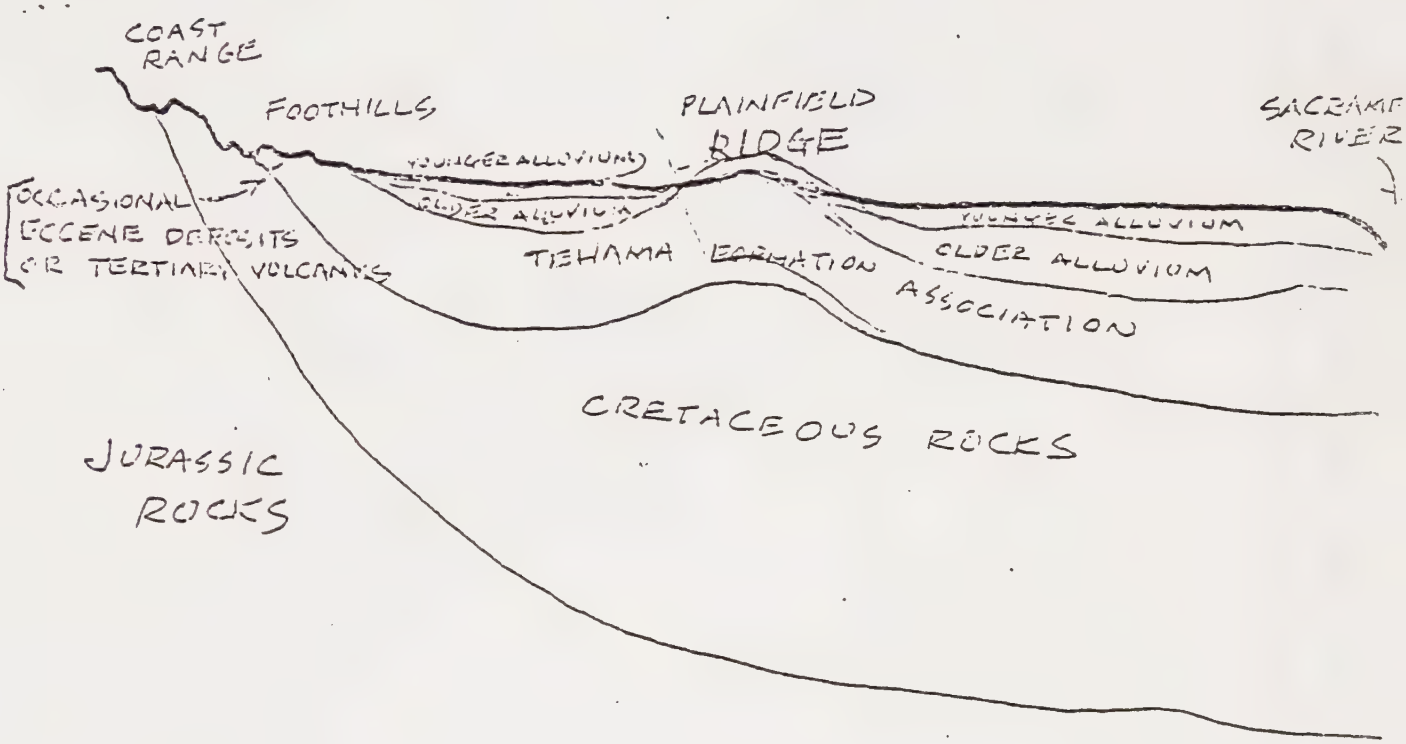
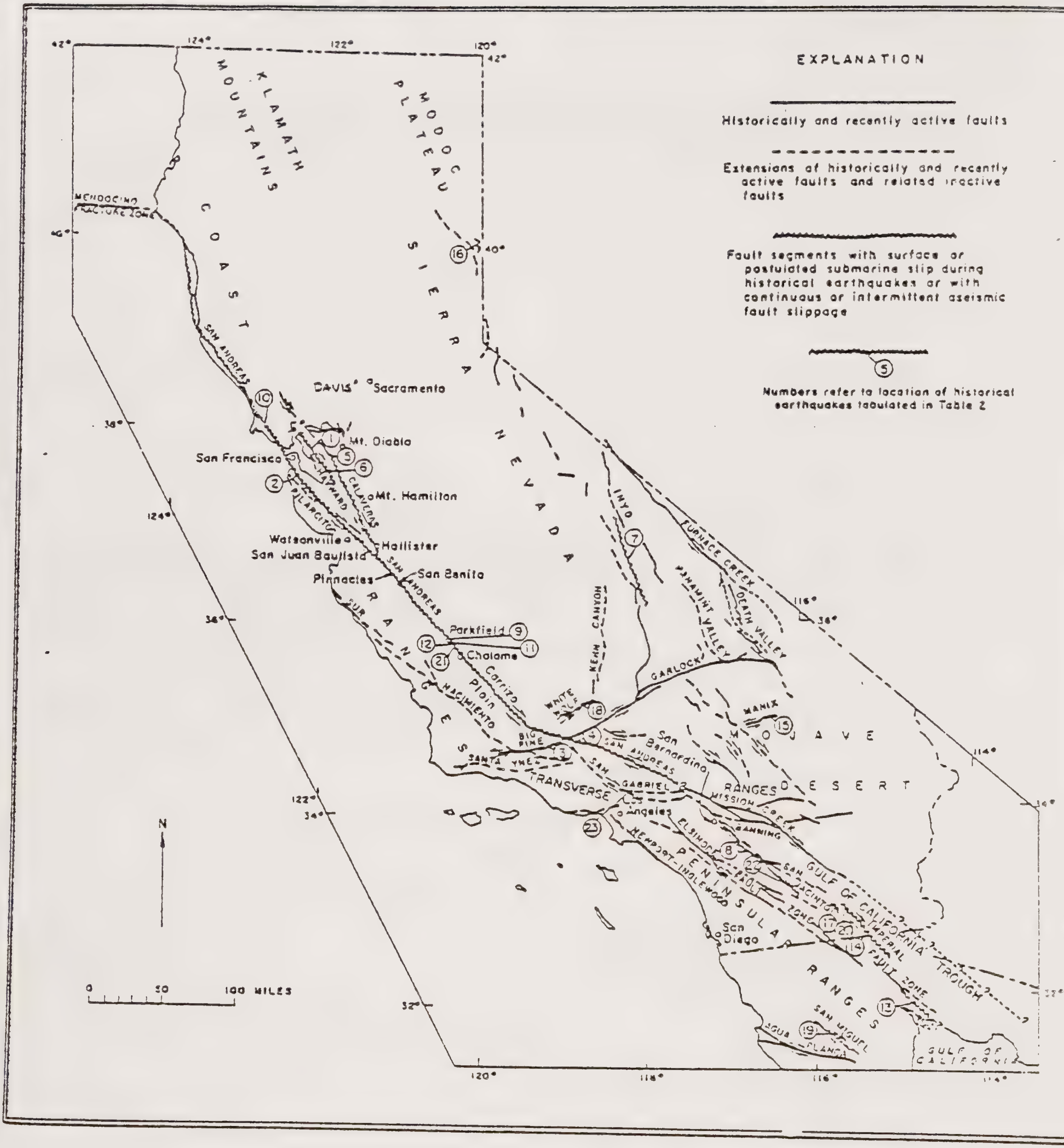


Figure 8:



SURFACE FAULTING DURING HISTORIC EARTHQUAKES.

FROM GREENSFELDER, 1972.

CRITICAL FACILITIES

Critical Due to Size:

Schools:

Birch Lane Elementary	1600 Birch Lane
North Davis Elementary	555 East 14th Steet
Pioneer Elementary	5215 Hamel
Valley Oak Elementary	1400 East 8th Street
West Davis Elementary	1221 Anderson Road
West Davis Intermediate	1207 Sycamore Lane
Ralph Waldo Emerson Junior High	5th & "B" Streets
Oliver Wendell Holmes Junior High	1220 Drexel Drive
Davis Senior High School	12th and "B" Streets

Halls and Theatres:

Auditorium, Civic Center	226 "F" Street
Cinema 2 Theatre	2nd and "E" Streets
Varsity Theatre	616 2nd Street
Veterans Memorial Center	230 East 14th Street

Businesses:

Armco Steel Corporation	Road 32
Pacific Standard Life Insurance Co.	3820 Chiles Road

Critical Due to Function:

Fire Department:

Station #1	5th and "E" Streets
Station #2 No longer functioning	
Station #3	425 Mace Boulevard

Police Department:

708 Third Street

Utilities:

Pacific Gas and Electric	
Davis Substation	3rd and "L" Streets
Regulator Station	1st and "A" Streets
Regulator Station	Covell and "L" Streets
Business Office	314 "F" Street

Pacific Telephone	
Main Unit	Third and "C" Streets
Toll Repeater Hut	Olive Dr. (near Dodge dealer)
Maintenance	2nd and "L" (behind PG&E)
Business Office	333 "F" Street

Water Department:

Central Davis Waste Water Treatment Plant	County Road 28 H, Three miles east of County Rd. 102
El Macero Waste Water Treatment Plant	2.5 miles south of I-80, .5 mile east on levee road between Putah Creek and levee.
Sewer lift station	
Manzanita Sewer	Manzanita Ln. at Covell Blvd.
El Macero Sewer (will be replaced)	East of South El Macero Dr., south of Clubhouse Drive.
Lift Station	3rd St. between "K" and "L" Streets
Lift Station	5th St., east edge of City Corporation yard

Wells Critical because of High Yield:

#11	14th and "F" Streets
#12	Sycamore Lane west of Harvard Drive
#13	Between Pacific Dr. and "L" Street west of Spruce Lane
#18	Russell Blvd. east of Lake Blvd.
#19	Between Corona Dr. and Anza Avenue south of Catalina Dr.
EM1	South of County Club Dr., east of Clubhouse Dr.
EM2	South El Macero Dr. and Clubhouse Drive

Other Wells:

#1	Between "D" and "E" Streets, south of 7th Street
#6	Miller Dr. between 7th and 8th Streets.
#7	Between 10th, 11th, "F" and "H" Streets.
#10	West side of East Davis Park Center

#14	South edge of City Corporation Yard
#15	South of Manzanita Sewer
#16	South of Cowell, east of El Campo Ave.
#17	South intersection of Catalina Avenue and Anza Avenue
Tanks -	In Southern Pacific Depot area South of 8th Street, east of Oeste Drive

DEFINITIONS

Alluvium: Unconsolidated soil which has been deposited by a stream or other running water during comparatively recent geologic time.

Amplification: Augmentation of earthquake waves due to physical changes in near-surface layers.

Compaction: Reduction in bulk of fine-grained sediments as a result of weight of overlying material.

Displacement: Movement of earth's surface adjacent to a fault as a result of an earthquake.

Epicenter: Point on earth's surface directly above focus, or origin, of earthquake. Used to denote "center" of earthquake.

Fault: An area or line of fracture of rocks within the earth and on its surface. Displacement has occurred at some point in time along all faults.

- Active fault: Displacement has occurred within recent geologic time, usually within 10,000 years.
- Inactive fault: No displacement has occurred within recent geologic time.

Focus: Center of the earthquake within the earth, from which earthquake waves originate. Also called the hypocenter.

Freeboard: The height above the recorded high-water mark of a dam.

Geomorphic: relating to the solid surface features of the earth.

Geologic hazard: area of geologic instability, such as earthquake fault, rock formation, which could result in damage to structures or people.

Igneous rock: rock resulting from volcanic action, solidified molten rock.

Intensity: A subjective description of earthquake severity based on effects on humans and/or structures. Intensity is usually measured on the Modified Mercalli Scale. (see fig. 2)

Liquefaction: Loss of soil stability and structure due to an increase of fluid.

Magnitude: A measure of the strength of an earthquake as determined by observation on a seismograph.

Metamorphic Rock: Igneous or sedimentary rock transformed by heat and pressure.

Sand, Silt and Clay: These terms refer to mineral size distributions in which sand particles are largest, silt medium and clay fine. In general, the smaller particle soils hold more water and are therefore less stable than larger particle soils.

Sedimentary rock: rock composed of grains cemented together over time.

Seiche: Oscillations in a closed body of water caused by earthquake (or other) waves which start it in motion.

Subsidence: The settling or sinking of land, occurring most often on fill-type land with a high water content.

Tsunami: Tidal wave occurring as a result of an underwater earthquake.

SCENIC HIGHWAYS ELEMENT

The City of Davis adopted the Yolo County Scenic Highways Element by reference (Resolution #1807)